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THE VIEW FROM THE OTHER END OF THE MICROSCOPE
OR
I'D RATHER BE FLYING

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ABSTRACT

For years we have looked at the pilot, and (in our infinite wisdom), have decided among ourselves that the more a simulator looks, feels and smells like an aircraft the more capable a training device it will be. Granted, we have made great leaps forward in computer, visual and motion system technology, and convinced ourselves and many others of the great future of aircrew training devices. However, somewhere along the way to selling ourselves and the rest of the world, we forgot to convince the pilot. This paper takes a figurative walk through the last 20 years in the simulator world. It looks "back through the microscope" from the pilot's point of view. The accusation is that (despite our good intentions) we have 1) overestimated the simulator's capabilities; 2) failed to plan adequately for its use; 3) overemphasized fidelity in the place of training capability; and 4) overcomplicated these devices by trying to incorporate too many "whistles and bells." In doing so we have developed pilots who aren't fighting to "fly" simulators. The basic recommendation is that we as developers, buyers, and managers of aircrew training programs might better serve the pilot's and our needs if we did a better job looking at the simulator as part of a total training program rather than as an end in itself.

The scene: a Tactical Air Command Base somewhere in the southwest. The new mission simulator has been in operation for a month. The building is new and beautiful with efficient air conditioning, plush carpets, and comfortable briefing rooms. It's been said that this mission simulator will save lives, fuel, time and money. It has the latest technologies incorporated into the student and instructor stations: motion, visual, electronic warfare, voice masking, automated instruction, and a host of other goodies. As part of a building block approach, additional sophisticated technologies will be incorporated within the next 10 years.

Still, the pilots avoid the facility like the plague. Getting into the simulator ranks in the desired activity list somewhere just below child support, alimony, and knee surgery. Having a session in the simulator is something pilots avoid if possible and don't admit to if forced to.

How can this be? Five years and \$100,000,000 has been spent to develop, produce and field this simulator. The best minds of the developers, producers and users have supposedly been put together in the effort to bring these simulators to use.

It really seems that something's incongruent has happened. I remember my first experiences with simulators with a great fondness and respect. I had a little simulator time during pilot training, but my first real experience was in my first assignment flying Aeromedical Evacuation in the C-131 (Convair 240, T-29).

As I understood it then, the simulator had been built in the early fifties and was condemned in the late fifties. We were using it in the late sixties because it was the only one that had ever been produced and we had to have something. To make matters worse it was designed for the Convair 240. The Convair 240 and the nine models of the T-29 and C-131 were basically the same aircraft. However, there were

just enough differences (primarily in the electrical system) to make trying to teach all models in the same simulator an interesting experience at best. Talk about "this doesn't really fly like the airplane": This simulator made nonfidelity an art form!

It's worth a few minutes to digress and describe this simulator. It had what I would call a first generation visual system: frosted windows with a rheostat to turn the lights up and down. This way you could simulate flying in clouds (lights down), heavy clouds (lights further down), thunderstorms (lights off), lightning (lights off with strobe lights going on and off), no clouds (lights full on), or breaking through a ragged cloud layer (lights on and off). As an added bonus there was a visual check for an engine fire. If there was a "real" fire, as opposed to faulty instrument indications, the instructor could turn on a red Christmas tree light that flashed just outside the side frosted window of the engine on fire. Eat your heart out visual engineers!

This simulator was not lacking in aural cues either. The engine sound track resembled one of those World War II movies when 300 B-17's are flying over Potsdam. Changes in power were merely reflected by changes in volume. The crash noise was a classic. I'm just sure it originated from an Abbot and Costello movie. About the only thing it needed to complete the vaudeville image was a scream at the end and the sound of one breaking glass. My favorite aural cue was ice on the propellers. Now it's tough to see ice on the propellers even in the airplane. Your only clue is usually the sound of the ice shedding and hitting the fuselage. In the simulator this was simulated with a small axle parallel to the outside of the simulator. Attached to the axle were varying lengths of spring wire with various size steel balls at the ends. As the axle rotated the balls would spring back and hit the fuselage at irregular intervals. I never had real prop ice, but I was sure, that if I ever did, it would sound just like that.

Now there was at least one way that this simulator was ahead of its time. That was in the area of nasal cues. I have seen simulators that people said "stunk", but, to this day I have yet to see a simulator with nasal cues. This particular feature was one of my favorites, and it was used in conjunction with simulating an electrical fire. No fancy keyboards or CRTs existed to input this emergency. The procedure was for an instructor to take a piece of insulated wire (provided) and clamp it between two terminals next to the intake duct for the cockpit air conditioning system. Current was then applied to the terminals and the resulting short circuit burned the insulation off the wire. The inevitable smoke flowed into the cockpit with the trainees. Now that's imagination and realism all rolled up into one. Which brings up the subject of the instructor station...

The instructor station was really something. As I said before no fancy keyboards or CRTs existed. Neither was there auto demo, graded maneuvers or programmed emergencies. The instructor had before him approximately 500 marked switches and rheostats on an electrical panel. Typically he was busier in the back than the guys up front controlling each maneuver and malfunction with a number of individual controls.

What about fidelity? Now there's a laugh. The simulator compared to the Convair like a Porsche does to a Peterbilt. You fought the simulator all the time. Talk about overcontrol; that's what you did in the simulator. Holding a heading was like balancing on a beach ball. All nine models of the T-29 and C-131 were taught in the simulator so the instrument panel wasn't correct for anyone. The electrical system in the Convair was the most crucial and the most difficult system to learn. In addition, the simulator didn't have all the instruments in the right place for any of the models. Talk about antiquity and negative state of the art! It was all there in our simulator.

What you may be expecting to hear is how much we hated the simulator, and, with all the improvements since then, why there isn't any reason pilots should feel the way they do about simulators. Actually what I'd like to say is that we loved it and there are some very good reasons why pilots are not killing themselves for the opportunity to fly simulators.

The Convair simulator was great! I always looked forward to a week at the simulator; even twice a year; even on my tenth trip. Why? Because I learned something and what I learned was meaningful. Well you ask, what was so wonderful about that particular simulator?

It had a number of things going for it that more than compensated for the lack of technology. Many of these things are not present in our simulator programs today. First, the emphasis was that the simulator was part of the training program. Now this may seem obvious, but in many cases it is not. Our week at Scott was not one simulator ride after another. The simulator was merely a tool used in a refresher course which emphasized system operation and emergency procedures. Simulator rides were used to demonstrate principles learned in class, emphasize systems lessons, demonstrate malfunctions and give the pilot a chance to practice what he had learned. The simulator was not the training program.

Secondly, since the simulator was not the training program, there was no attempt to teach everything in it. If the simulator did not have the capability to enable training a particular maneuver there were not any squares to fill to show that we tried.

Third, the simulator was used to make what flying time we did have more effective. Even in 1967, flying time was not in abundance. What limited training time we had was valuable. We used the time in the simulator to train to a level commensurate with the simulator's capabilities. It was never considered that we would use simulator time to replace flying time. We needed the simulator time to make our flying time more meaningful, productive, and safe.

Fourth, and this goes along with two and three, we didn't worry about "fidelity" as an end. The important thing was the ability to train a particular maneuver effectively. Sure, it handled poorly, but it was understood that, if we could fly the simulator and handle emergency and instrument procedures, the real thing would be a breeze. From experience I can tell you that this was true.

Fifth, and probably most important was the ability and attitude of the instructors. Teaching in the simulator was not rotated among whomever could be coned into teaching in the simulator. The simulator instructor position was a truly selective position and individuals who were assigned to the position were the ones who had the inside track for good report cards and promotions. As a result, we rarely lacked quality instruction. The instructors were professional, knowledgeable and excellent teachers. This made a real difference. As a testimony to the quality of this program, the simulator was given much of the credit for over 500,000 accident-free flying hours that the 375th Aeromedical Airlift Wing enjoyed operating 20-year old aircraft. When the aircraft were retired in the early seventies, their accident-free record remained untamished.

So what's the point? What can we learn from this experience? For years we've been meeting like this and telling each other what wonderful things we're doing, have done, and hope to do in the future for the simulator world. In the process, we've looked at the pilot "through a microscope." We've analyzed him, scrutinized him, and studied him. We've studied his aircraft, his mission and his bodily functions. We've made great strides in technology, digitized computers, expanded fields of view, increased resolution and focussed on fidelity. Our reward for all our work has been a pilot who would much rather play "pac-man" than train in our \$10-\$100 million electronic training devices. Have we done something wrong? If so, where have we gone wrong? How can we do it better? Certainly with the quality of our equipment our programs should be able to easily exceed the effectiveness of earlier programs like Air Evac's. To me the problems are observable, predictable, and correctable...but not easily.

These problems are tied up in four words:

1. Overestimate
2. Underanticipate
3. Overemphasize
4. Overcomplicate

There isn't any one sector that can be identified as the guilty party. Everyone, yes everyone, has had a part. These include developers, the contractors, acquisition agencies, the Pentagon, command headquarters, testing agencies, requirements people,

and...yes...the pilots themselves.

The first word is overestimate, specifically the simulator's capability to meet all our needs in a certain limited time. To me this tendency started with the oil embargo in 1973. Ever noticed how fashionable it is these days to trace all our problems back to the Arab oil embargo. Anyway, up until then, simulators had been going along fine in their proper role and gaining in capability. Then someone got the bright idea that we could use simulators to replace flying time rather than just increasing the effectiveness of it. Therefore the more we used simulators the less we needed airplanes and the more we could save gas. The conclusion was that simulators were pretty good but many dreamed that with some good old American ingenuity simulators could be developed so that pilots would never have to leave the ground...except in an emergency, of course.

This led to a flurry of technological efforts and flight hour tradeoff studies. Some elements of the Air Force committed themselves to giving up flight hours in exchange for a certain simulator capability. These estimates were based on projections of the expected technological advances. Unfortunately the technology was not all that was expected as soon as expected. Furthermore the estimates had been fudged a little to make the case look better because surely they wouldn't take away all that flying time.

Now consider the pilot. He knew instinctively that he could not minimize his flight time to the extent that his proficiency deteriorated. But everyone said "Trust me, you'll really be impressed with its capability. Reluctantly, he said "OK".

Five years later the simulator arrives. It's two years late and the flying hour cuts have taken place two years earlier. Unfortunately the costs of the full visual capability have escalated and it's been cut from the program. Besides there wasn't enough spare memory in the computers to handle the visual system. Also the flying qualities aren't the same as the airplane because the simulator was built on design data, and flight data wasn't available until after the critical design review. That was four years ago but the program couldn't afford the cost growth that would be required to use flight test data. Or we have the flight test data but it doesn't have enough data points or our sampling rate needs to be larger or any number of a myriad of technical reasons why it isn't quite right or wasn't delivered on time. The base newspaper has an article about the simulator and says that it has just passed its reliability testing with flying colors. However, one-half hour into the first mission it has five computer halts. These are explained as merely software "glitches" that were not reflected in the reliability data because software does not fail. I could go on and on, but why beat a dead horse. Simply classify it under the first word: We overestimated what we could do.

The second word is underanticipate. It could also be three words: lack of planning. It seems in the last few years many simulators arrive on base just about the same time as the training syllabus. One of the neat things about the Air Evac simulator was that it was part of the ground training program. It's obvious that the training program should be conceptualized and then it should be determined where a simulator or other training device could be used to effectively train what has to be trained. Trainer features seem to be obtained like someone in the

grocery store without a list: whatever sounds good is what we order. There seems to be minimal thought placed in (1) developing a syllabus, and (2) requesting those features which will best fit in with that syllabus.

Overemphasize is the third word and fidelity is the one that goes along with it. Simulation is exactly that: simulation. By definition, no simulator will ever have total fidelity. Furthermore, total fidelity doesn't guarantee an excellent training device. The real airplane has complete fidelity, but is only an excellent training device with a competent instructor. The Air Evac simulator had very little "fidelity", but the way it was used made it an extremely capable training device with a great deal of training capability. Our preoccupation with "fidelity" has driven up the cost and complexity of simulators and detracted from their training capability.

Consider the pilot in the field again. He hears everyone talking about fidelity. Therefore, when he goes to the simulator he's looking for something to be not quite like the aircraft. He doesn't have to look far, and, no matter how much money we spend, he will always be able to find things that are not quite like the aircraft. And, if all we're concerned about is fidelity, we can certainly get that much cheaper and quicker in the aircraft. Rather we should talk training capability. That's what we're after, isn't it? And, it should be training capability for those portions of the mission for which the simulator is best suited and designed.

The last word is overcomplicate, and it's really a synthesis of the other three. Our preoccupation with fidelity leads to expensive systems that are difficult to maintain and costly to operate. Furthermore we deemphasize training capability. Our failure to design the training program in advance of the simulator leads to the "give me everything there is and we're bound to build an effective training program" approach. The problem is that it's always too expensive, something always gets cut, and there is no way to evaluate what is most important because there isn't any training program with which to compare it. A good example is that many of the instructor stations have many expensive, underutilized systems. Had there been a development of the training program first these could have been identified as unnecessary and the funds diverted to other more valuable features.

Well, those are the problems as I see them. And it has been said many times that anyone can be a critic. What do you do to make it better? The first recommendation is, of course, to design the training program first. The simulator should then be appropriately integrated into the training program. This is not new advice, but it still holds true. With this kind of approach you can take a look at the tasks you need to train most and let the developer work to obtain that capability. This also precludes the tendency to ask for the moon.

Secondly, be realistic with schedules. The acquisition agency puts out a request for delivery of a simulator in three years, knowing this is an unattainable goal. The rationale for this procedure is based on deliveries being historically late. The contractor, to ensure contract award concurs with this schedule.

Don't forget the software, documentation and spare parts. As a pilot I must admit these are three fuzzy-wuzzy areas in my mind except when the simulator doesn't work, breaks down and can't be fixed. Mumbo-jumbo about the reliability figures do not consider software failures as failures, the level of documentation that we ordered doesn't cover this, and "this part has 'downed' the simulator but we won't be able to get it for six months" doesn't build confidence in the capability of these devices.

The last one is probably the toughest one and the key to the whole program: obtaining good, motivated, exceptional instructors. This involves changing an entire attitude about simulators. In many cases, simulator programs have become the dumping ground for passovers. And if they're not passovers when they get there, they are soon after because they are not recognized for their contributions.

Simulators have considerable capabilities. They can enhance and improve any training program. The important thing to remember is they cannot replace an airplane, or enhance a poorly conceived and executed training program. Thank you.

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